

A Review on Design Consideration and Need of Fixture in Manufacturing Industries

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Abstract— Fixtures, the component or assembly that holds a part undergoing machining, must be designed to fit the shape of that part and the type of machining being done. A fixture can be designed for the particular job using production tool which make the standard machine tool more versatile to work as specialized machine tool. The fixture designing and manufacturing is considered as the complex process and required knowledge of different areas such as geometry, dimensions, and tolerances, procedure and manufacturing process. This paper gives detailed definition of fixture and also gives the design consideration of fixture associated with the fixture in manufacturing.

Keywords— Fixture, Advantages, Design, Design consideration, manufacturing, welding fixture, CMM

7. INTRODUCTION

A fixture is a device for locating, holding and supporting a work piece during a manufacturing operation. Fixtures are essential elements of production processes as they are required in most of the automated manufacturing, inspection, and assembly operations. Fixtures must correctly locate a work piece in a given orientation with respect to a cutting tool or measuring device, or with respect to another component, as for instance in assembly or welding. Such location must be invariant in the sense that the devices must clamp and secure the work piece in that location for the particular processing Operation. Fixtures are normally designed for a definite operation to process a specific work piece and are designed and manufactured individually.

The correct relationship and alignment between the components to be assembled must be maintained in the welding fixture. To do this, a fixture is designed and built to hold, support and locate work piece to ensure that each component is joined within the specified limits. A fixture should be securely and rigidly clamp the component against the rest pads and locator upon which the work is done.

Fixtures vary in design from relatively simple tools to expensive, complicated devices. Fixtures also help to simplify metalworking operations performed on special equipments. Fixtures play an important role on reducing production cycle time and ensuring production quality, by proper locating and balanced clamping methods .Therefore to reduce production cost, fixture design, fabrication and its testing is critical.

1.1 Purpose

A fixture's primary purpose is to create a secure mounting point for a work piece, allowing for support during operation and increased accuracy, precision, reliability, and interchangeability in the finished parts. It also serves to reduce working time by allowing quick set-up, and by smoothing the transition from part to part it frequently reduces the complexity of a process, allowing for unskilled workers to perform it and effectively transferring the skill of the tool maker to the unskilled worker. Fixtures also allow for a higher degree of operator safety by reducing the concentration and effort required to hold a piece steady.

Economically speaking the most valuable function of a fixture is to reduce labor costs. Without a fixture, operating a machine or process may require two or more operators; using a fixture can eliminate one of the operators by securing the work piece.

The basic purposes of developing and using suitable fixtures for batch production in machine shops are:

- To eliminate marking, punching, positioning, alignments etc.

- Easy, quick and consistently accurate locating, supporting and clamping the blank in alignment of the cutting tool
- Guidance to the cutting tool like drill, reamer etc.
- increase in productivity and maintain product quality consistently
- To reduce operator's labour and skill – requirement
- To reduce measurement and its cost
- Enhancing technological capacity of the machine tools
- Reduction of overall machining cost and also increases in interchangeability.

Hence, provision of fixtures as production tools provides the following:

- Manufacture accurately duplicate and interchangeable parts. Jigs and fixtures are specially designed so that large numbers of components can be machined or assembled identically, and to ensure interchangeability of components.
- Facilitate economical production of engineering components.
- Make operation of parts fairly simple which otherwise would require a lot of skill and time.

1.2 The advantages of using fixture.

- Production increase.
- Low variability in dimension, thereby leading to consistent quality of manufactured product.
- Cost reduction.
- Ensures interchange ability and high accuracy of parts.
- Reduces the need for inspection and quality control expenses.
- Reduces accident, as safety is improved.
- Semi-skilled machine operators can easily use them thereby saving the cost of manpower.
- The machine tool can be automated to an appreciable extent.
- Complex and heavy components can be easily machined.
- Easy assembly operations save labour, and also lead to reduction of defective products.

1.3 Function of Fixture

- Gripping a work piece in the predetermined manner of firmness and location.
- Holding components rigid and prevent movement during working in order to impart greater productivity and part accuracy.
- Supporting and locating every component (part) to ensure that each is drilled or machined within the specified limits.
- Positioning components accurately and maintain relationship and alignment between the tool and the work piece correctly to perform on the work piece a manufacturing operation.

1.4 Element of Fixture

Generally, the entire fixture consists of the following elements

- Locators: A locator is usually a fixed component of a fixture. It is used to establish and maintain the position of a part in the fixture by constraining the movement of the part.
- Clamps: A clamp is a force actuating mechanism of a fixture. The forces exerted by the clamps hold a part securely in the fixture against all other external forces.
- Fixture Body: Fixture body, or tool body, is the major structural element of a fixture. It maintains the relationship between the fixture elements namely Locator, clamps, supports, and the machine tool on which the part is to be processed.
- Supports: A support is a fixed or adjustable element of a fixture. When severe part displacement is expected under the action of imposed clamping and processing. Fixtures for work piece comprise the usual locating and clamping elements as used in other

fixtures. However, the effect of heat and prevalence of welding spatter must be taken into account while designing hot joining fixtures.

8. DESIGN

Fixture components may be built into various arrangements to accommodate different workpieces. Fixtures must always be designed with economics in mind; the purpose of these devices is to reduce costs, and so they must be designed in such a way that the cost reduction outweighs the cost of implementing the fixture. It is usually better, from an economic standpoint, for a fixture to result in a small cost reduction for a process in constant use, than for a large cost reduction for a process used only occasionally. A common bench vise the left jaw is the immovable surface, and the right jaw is the movable clamp.

Most fixtures have a solid component, affixed to the floor or to the body of the machine and considered immovable relative to the motion of the machining bit, and one or more movable components known as clamps. These clamps (which may be operated by many different mechanical means) allow work pieces to be easily placed in the machine or removed, and yet stay secure during operation. Many are also adjustable, allowing for work pieces of different sizes to be used for different operations. Fixtures must be designed such that the pressure or motion of the machining operation (usually known as the feed) is directed primarily against the solid component of the fixture. This reduces the likelihood that the fixture will fail, interrupting the operation and potentially causing damage to infrastructure, components, or operators.

Fixtures may also be designed for very general or simple uses. These multi-use fixtures tend to be very simple themselves, often relying on the precision and ingenuity of the operator, as well as surfaces and components already present in the workshop, to provide the same benefits of a specially-designed fixture. Examples include workshop vises, adjustable clamps, and improvised devices such as weights and furniture.

Designing fixtures depends upon so many factors. These factors are analyzed to get design inputs for fixtures. The list of such factors is mentioned below:

- Study of work piece and finished component size and geometry.
- Type and capacity of the machine, its extent of automation.
- Provision of locating devices in the machine.
- Available clamping arrangements in the machine.
- Available indexing devices, their accuracy.
- Evaluation of variability in the performance results of the machine.
- Rigidity and of the machine tool under consideration.
- Study of ejecting devices, safety devices, etc.
- Required level of the accuracy in the work and quality to be produced.

2.1 Design Consideration in Fixture Design.

- The main frame of fixture must be strong enough so that deflection of the fixture is as minimum as possible. This deflection of fixture is caused because of forces of cutting, clamping of the work piece or clamping to the machine table. The main frame of the fixture should have the mass to prevent vibration and chatter.
- Frames may be built from simple sections so that frames may be fastened with screws or welded whenever necessary. Those parts of the frame that remain permanently with the fixture may be welded. Those parts that need frequent changing may be held with the screws. In the situation, where the body of fixture has complex shape, it may be cast from good grade of cast iron.
- Clamping should be fast enough and require least amount of effort.
- Clamps should be arranged so that they are readily available and may be easily removed.
- Clamps should be supported with springs so that clamps are held against the bolt head wherever possible.
- If the clamp is to swing off the work, it should be permitted to swing as far as it is necessary for removal of the work piece.
- All locator's clamps should be easily visible to the operator and easily accessible for cleaning, positioning or tightening.
- Provision should be made for easy disposal of chip so that storage of chips doesn't interfere with the operation and that their removal during the operation doesn't interfere with the cutting process.

- All clamps and support points that need to be adjusted with a wrench should be of same size. All clamps and adjustable support points should be capable of being operated from the fronts of the fixture.
- Work piece should be stable when it is placed in fixture. If the work piece is rough, three fixed support points should be used. If work piece is smooth, more than three fixed support points may be used. Support point should be placed as farthest as possible from each other.
- The three support points should circumscribe the centre of gravity of the work piece.
- The surface area of contact of support should be as small as possible without causing damage to the work piece. This damage is due to the clamping or work forces.
- Support points and other parts are designed in such a way that they may be easily replaced if they break.

In the design of a fixture, a definite sequence of design stages is involved. They can be grouped into four broad stages of design development.

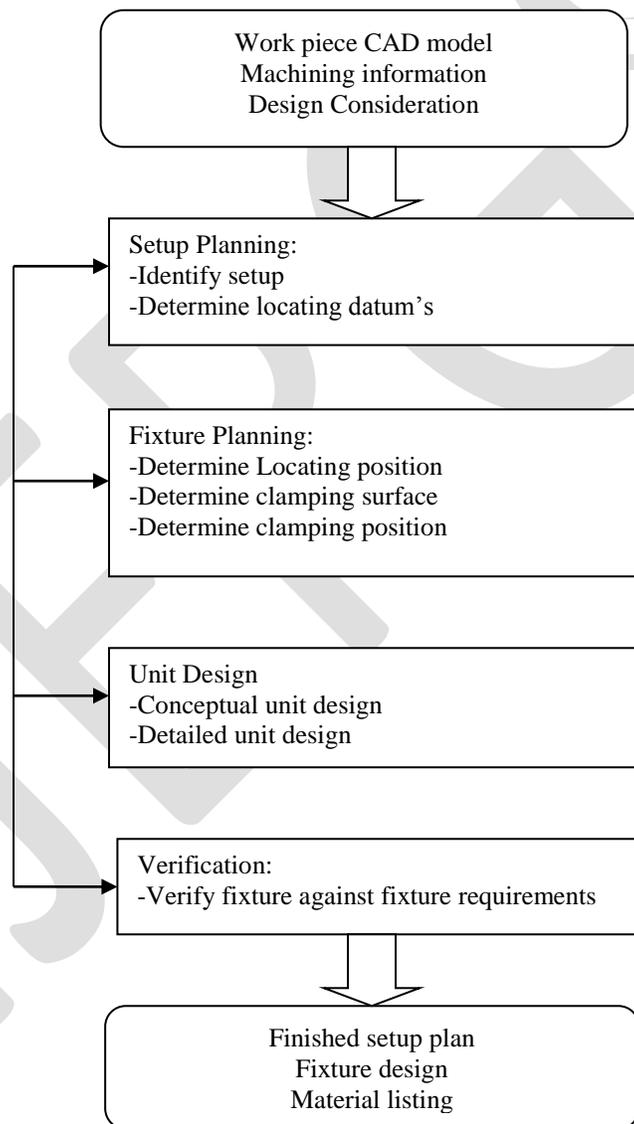


Fig No.1 Steps of fixture Design.

- Stage one deals with information gathering and analysis, which includes study of the component which includes the shape of the component, size of the component, geometrical shape required, locating faces and clamping faces. Determination of setup work piece orientation and position.

- Stage two involves product analysis such as the study of design specifications, process planning, examining the processing equipment's and considering operators safety and ease of use. Determination of clamping and locating position. In this stage all critical dimensions and feasible datum areas are examined in detail and layout of fixture is done.
- Stage three involves design of fixture elements such as structure of the fixture body frame, locators, base plate, clamping and tool guiding arrangement.
- Stage four deals with final design and verification, assembly of the fixture elements, evaluation of the design, incorporating the design changes if any required and completion of design.

9. NEED OF FIXTURE IN MANUFACTURING INDUSTRIES.

Some machining operations are so simple which are done quite easily, such as turning the job is held in position in the chuck and turning operation is done easily. No other device is used to hold the job or to guide the tool on the machine in such an operation.

But some operation are such type in which the tool is required to be guide by means of another device and also some jobs are of such forms which guides the tool is 'jig' and the device which hold the job in position is called 'fixture'.

It serves that to reduce working time by allowing quick set up and smoothing the transition from part to part. It frequently reduces the complexity of a process, allowing for unskilled workers to perform it and effectively transferring the skill of the tool maker to the unskilled worker.

It also allows for higher degree of freedom of operator safety by reducing the concentration and effort required to hold a piece steady. Economically speaking the most valuable function of a fixture is to reduce labour cost by eliminating one of the operators instead of two or three, by securing the work piece.

10. CONCLUSION

Fixture is the manufacturing tool that is employed to reduce interchangeable and identical components. It is unique work holding device designed specifically for machining and assembly.

The paper explained that since the design of fixture is dependent on numerous factors and design consideration of fixture. From the study we can conclude that there are different steps and approaches are available for designing the fixture.

The fixture in manufacturing industries is very useful that reduces the worker fatigue and provides higher degree of freedom of operator safety by reducing the concentration and efforts required to hold the work piece.

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